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NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE FLOW OF MAPLE SAP

BY A. H. WOOD

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

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THE FLOW OF MAPLE SAP

BY A. H. WOOD.

NOTE.—Professor Wood resigned his position on the Station Staff November 1, 1894.

This bulletin is chiefly based upon observations made while engaged in procuring samples of maple sap for investigation as recorded in Bulletin No. 25.

These results are submitted at this time, not as a complete study of the subject, but because the results recorded may be of immediate value to the sugar makers of the state.

It has become a common practice to tap maples to a depth of only about an inch. This practice is based upon the belief that the flow of sap comes chiefly from the wood of very recent growth, and that to tap beyond the growth of the last six or eight years is a useless expenditure of labor and an unnecessary injury to the tree.

To determine as to the correctness of this belief, as well as to investigate the comparative richness of the sap from the outer and inner wood, the following experiments were made. In the spring of 1892, two thrifty rock maples about fourteen inches in diameter and growing in thick woodland were selected and tapped as shown in Table 1.

TABLE 1.—RELATION OF DEPTH OF TAPPING TO FLOW OF SAP.

1892.	TREE A.		TREE B.	
	1¾ inches deep (south).	3½ inches deep (north).	1¾ inches deep (north).	3½ inches deep (south).
March 25	5.0 lbs.	8.0 lbs.	7.0 lbs.	8.0 lbs.
" 26	3.5 "	3.0 "	1.5 "	3.5 "
" 28	4.0 "	6.0 "	1.5 "	3.0 "
" 30	7.5 "	14.0 "	2.0 "	6.0 "
April 1	8.0 "	16.0 "	2.0 "	6.0 "
" 4	2.0 "	5.0 "	1.0 "	3.0 "
" 10	11.0 "	19.0 "	8.0 "	17.0 "
" 12	8.5 "	18.5 "	8.0 "	20.0 "
" 16	4.0 "	16.0 "	5.0 "	15.0 "
	53.5 lbs.	105.5 lbs.	36.0 lbs.	81.5 lbs.

The 1¾ inch holes yielded 89.5 pounds of sap, while the 3½ inch holes gave a little more than double that amount, or 187 pounds.

In 1893, tree 8 was tapped twice, one hole being 1¼ inch deep, and the other 2½ inches. Tree 9 was tapped 2½ inches deep, and tree 10 1¼ inches. These trees were large, thrifty, shade trees. The rate of flow was determined by noting the amount of sap that flowed in two minutes, and in Table 2 this amount is expressed in cubic centimeters.

April 9th, the 1¼ inch holes were deepened to 2½ inches, the rate of flow being taken just before and after the deepening.

TABLE 2.—RELATION OF DEPTH OF TAPPING TO FLOW OF SAP.

1893.	Time.	Tree 8.		Tree 9.	Tree 10.
		1¼ inch.	2½ inch.	2½ inch.	1¼ inch.
March 14...	11:30 a. m.	15.0 c.c.	26.0 c.c.	46.0 c.c.	22.0 c.c.
" 14...	3:00 p. m.	6.0 "	12.0 "	22.0 "	15.0 "
" 21...	10:00 a. m.	6.0 "	6.5 "	8.5 "	7.5 "
" 22...	3:00 p. m.	7.0 "	12.0 "	11.0 "	7.0 "
" 25...	10:00 a. m.	4.0 "	7.0 "	5.5 "	4.5 "
" 2[illegible]...	3:00 p. m.	3.0 "	5.5 "	4.0 "	2.0 "
" 2[illegible]...	10:00 a. m.	2.0 "	6.0 "	12.0 "	6.0 "
" 2[illegible]... ..	2:00 p. m.	16.0 "	26.0 "	26.0 "	15.0 "
" 2..... ..	3:00 p. m.	15.0 "	18.0 "	20.0 "	12.0 "
April 9...	11:00 a. m.	7.0 " Deepened to 2½ in.	24.0 "	12.0 "	4.0 " Deepened to 2½ in.
" 9.....	11:00 a. m.	21.0 c.c.	22.0 "	12.0 "	18.0 c.c.
" 11...	10:30 a. m.	14.0 "	17.0 "	12.0 "	12.0 "
" 11.....	3:00 p. m.	6.0 "	7.0 "	.....	.....
" 12...	9:50 a. m.	31.0 "	37.0 "	47.0 "	44.0 "
" 20...	11:00 a. m.	9.0 "	17.0 "	14.0 "	9.0 "
Av. rate before April 9.....	11:00 a. m.	8.4 "	14.0 "	16.7 "	9.5 "
Av. rate after April 9...	11:00 a. m.	16.2 "	20.0 "	17.0 "	16.6 "

In this trial, the deepening of the 1¼ inch holes brought the rate of flow from these holes nearly to an equality with that from the holes originally 2½ inches deep. The increase is especially noticeable if a comparison is made between the rates of flow just before and after deepening.

April 17th, a tree about 12 inches in diameter was tapped 2 inches deep with a 1 inch bit, the hole was then bored 2 inches deeper with a ½ inch bit. An iron spout was driven into the

inner hole, and an old fashioned sheet iron spout driven under the outer one, so that the sap from the inner and outer wood could be gathered separately.

At the time of tapping, the rate was: Inner hole, 9 c.c. per minute ; outer hole, 6 c.c. per minute.

Three days later, April 20th, the run was 11 c.c. and 3 c.c. respectively. Thinking that the greatly decreased flow from the outer hole might be due to the free exposure of the sap-wood to the air, another similar tree was tapped in the same manner. The rate of flow from this second tree was 16 c.c. from the inner, and 13 c.c. from the outer hole. In both trees the flow from the inner wood exceeded that from the outer wood, although the diameter of the outer hole was double that of the inner one.

In 1894 four trees were tapped as follows: *R* tapped 2⅞ inches deep with a $\frac{13}{16}$ inch bit, and the hole continued 2⅞ inches with a ⅜ inch bit. An iron spout was driven into the inner hole, and the outer hole was closed with a rubber stopper through which tubes were passed to give outlet to the sap from the outer and inner wood without subjecting the outer wood to exposure to the air: *S* tapped 5½ inches deep with a ½ inch bit. A thin rubber stopper, through which a small tube was passed, was driven to the centre of the hole, the tube extending out through the centre of the spout driven into the outer wood of the tree. We were thus able to compare the rate of flow from the outer and inner wood with the same bore throughout: *T* tapped twice with a ⅜ inch bit. The holes 4 inches apart and apparently in equally favorable positions, one hole 6 inches deep, the other 2 inches deep: *U* standing near and similar to *T*, tapped with a ¼ inch bit, 6 inches deep. Table 3 gives the rate per minute in cubic centimeters.

TABLE 3.—RELATION OF DEPTH OF TAPPING TO FLOW OF SAP,

1894.	R.		S.		T.		U.
	3/8 in. Inner.	13-16 in. Outer.	1/2 in. Inner.	1/2 in. Outer.	3/8 in. 6 in. hole.	3/8 in. 2 in. hole.	1/4 in. 6 in. hole.
Mar. 17..	10.0 c. c.	14.0 c. c.	7.5 c. c.	4.5 c. c.	.....	....	.....
" 24..	6.0 "	5.0 "	9.5 "	4.5 "	25.0 c. c.	3.0 c. c.	17.0 c. c.
" 26..	8.0 "	6.0 "	13.0 "	6.5 "	19.0 "	4 5 "	18.0 "
" 29..	3.5 "	3.0 "	.....	.....	3.0 "	0.3 "	4.0 "
" 31..	6.0 "	4.5 "	8.5 "	7.5 "	14.0 "	0.2 "	15.0 "
Average	6.7 c. c.	6.5 c. c.	9.6 c. c.	5.8 c. c.	15.2 c. c.	2.0 c. c.	13.5 c. c.

Diameter of hole.	Hole 5 3/4 in. deep. 3/8 in. and 13-16 in.	Hole 5 1/2 in. deep. 1/2 in.	Hole 6 in. deep. 3/8 in.	Hole 6 in. deep. 1/4 in.
Aggregate rate of flow.	13.2 c. c.	15.4 c. c.	15.2 c. c.	13.5 c. c.

Although the rate of flow was taken but a few times in 1894, the results are in each case, in accord with those of the preceding years.

The flow from the inner wood of tree R exceeded that from the outer wood although the inner hole was less than half the diameter of the outer hole.

In S, with a hole of uniform diameter the flow from the inner wood was almost double that from the outer. The remarkable difference in the rate of flow from the 6 inch and 2 inch holes in tree T, raises the question as to the effect of a deep hole upon the flow from a shallow one near it. A reference to table 2 shows that deepening the shallow hole in the tree 8, in 1893, at once decreased slightly the flow from the deeper hole. The rate of flow from tree U is of interest, as showing the rapid flow from a deep, but small hole. A comparison of the rate of flow from holes of nearly equal depth but of various diameters is afforded by these four trees, as shown in table 3.

The only conclusions that can possibly be drawn from the result of these trials as shown in the three preceding tables, is that the flow of sap is very largely dependent upon the depth of

tapping; that the theory that all or nearly all of the sap comes from the outer wood is erroneous, and that our sugar makers may with great profit, tap their trees to a depth of four or five inches. The additional injury to the tree is slight, especially if the hole is small and the bark but slightly hewn away. Where a ⅜ inch bit is used and the bark practically uninjured by hewing, a majority of the holes will be grown over the first summer after tapping. If double the amount of sap can be obtained by tapping four inches deep, instead of two, and the sap be of nearly equal richness, then it is time to stop giving directions to tap but one inch deep as many have done on the assumption that the sap from the inner wood was scanty and poor.

In 1892 two trees with as uniform tops as could be found and standing in thick woodland, were tapped both on the north and south sides. A similar tree was tapped on the south and west sides. With trees 6 and 20, the south side yielded about 23 per cent. more than the north side, while with tree 12, the west side exceeded the south side by about 9 per cent. It is of interest in connection to depth of tapping to note that tree 6 was tapped 1½ inch deep, and trees 12 and 20, 2¼ inches deep. All with ½ inch holes. Table 4 gives the results in detail.

TABLE 4.—FLOW OF SAP FROM NORTH AND SOUTH SIDES OF TREES.

1892.	6.		20.		12.	
	North.	South.	North.	South.	West.	South.
March 25....	6.5 lbs.	6.5 lbs.	11.8 lbs.	10.0 lbs.	11.7 lbs.	12.2 lbs.
" 26....	2.0 "	2.5 "	6.5 "	7.0 "	3.0 "	3.5 "
" 28....	2.0 "	3.0 "	7.5 "	8.0 "	3.0 "	3.5 "
" 30....	3.5 "	5.0 "	18.7 "	22.7 "	4.0 "	4.5 "
April 1....	4.0 "	6.0 "	16.0 "	18.0 "	5.0 "	5.0 "
" 4....	2.0 "	2.5 "	4.0 "	4.0 "	3.0 "	2.5 "
" 10....	8.5 "	10.0 "	19.5 "	22.0 "	15.0 "	11.0 "
" 12....	8.0 "	9.5 "	19.0 "	22.5 "	20.0 "	14.5 "
" 16....	13.0 "	16.0 "	7.0 "	16.0 "	27.0 "	26.0 "
Total....	45.5 lbs.	61.0 lbs.	110.0 lbs.	130.2 lbs.	91.7 lbs.	82.7 lbs.

A few observations made in 1893 and 1894 are in accord with the results from trees 6 and 20. Without doubt differences in season and the exposure of the trees to the sun have much to do with the results from tapping on different sides of the

trees. As an illustration of the effect of the sun in some instances we will cite the following. In 1893 a thrifty maple standing in a small group of trees and exposed to the sun, was tapped on the north and south sides. The excess in favor of the south side was almost wholly due to the yield upon a day when the sun shone brightly, but with the temperature but slightly above freezing; the yield was, south side, 11 $\frac{5}{8}$ pounds, north side, 2½ pounds.

There can be little doubt as to the correctness of the common practice of tapping the south side whenever practicable.

There is a growing tendency to tap trees twice, putting the holes near together and letting the sap from both spouts drop into the same bucket. To test the profit of so doing the following trial was made: Six maples from twelve to sixteen inches in diameter, standing near together and with the same exposure, were divided into two groups, as nearly alike as possible in size, spread of branches, etc.

The trees in group *A* were tapped once with a ½ inch bit and 1½ inches deep. Those in group *B* were tapped twice, once with a ½ inch bit, and once with a ⅜ inch bit, the holes being 1½ inch deep and about 4 inches apart. Table 5 shows the yield by trees and by groups.

TABLE 5.—EFFECT OF TAPPING TREES ONCE AND TWICE.

1892.	Group A. Tapped once.			Group B. Tapped twice.		
	14	15	16	17	18	19
March 25	17.7 lbs.	18.5 lbs.	12.7 lbs.	19.0 lbs.	16.0 lbs.	16.5 lbs.
" 26	6.0 "	7.0 "	6.0 "	8.2 "	6.0 "	4.0 "
" 28	7.5 "	9.0 "	8.0 "	8.5 "	7.0 "	4.0 "
" 30	19.0 "	22.0 "	21.7 "	22.0 "	17.5 "	12.0 "
April 1	20.0 "	19.0 "	19.0 "	22.0 "	17.0 "	17.0 "
" 4	5.5 "	4.0 "	8.0 "	5.0 "	3.0 "	2.0 "
" 10	14.0 "	9.5 "	12.5 "	16.5 "	10.5 "	8.5 "
" 12	14.0 "	13.0 "	15.0 "	23.0 "	14.5 "	17.5 "
" 16	12.0 "	6.0 "	16.0 "	14.0 "	14.0 "	6.0 "
Total yield by trees	115.7 lbs.	108.0 lbs.	118.9 lbs.	138.2 lbs.	105.5 lbs.	87.5 lbs.
Total yield by groups		342.6 lbs.			331.6 lbs.	

The trees tapped but once gave slightly more sap than those tapped twice. When we consider the similarity of the trees in

the two groups and the nearly equal flow from all, with the exception of tree 19, it seems certain that little was gained in this case by tapping in the manner described. This is the result of a single trial, but if we remember that sugar makers have gradually changed from the use of the two-inch auger to the half and three eighths-inch bit for tapping, on the ground that they obtain nearly or quite as much sap with much less injury to the tree, is it not reasonable to expect that holes three or four inches apart should influence the flow from each other? This point has been referred to in connection with tree *Z*, Table 3. More sap may frequently be obtained by this method of double tapping but the question arises whether, if we are able to tap a tree two or more times, it is not true economy to place the holes as far apart as possible, even if extra buckets are required for so doing.

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